APPENDIX B

FIELD SURVEY PROCEDURES
for
ENERGY MONITORING AND CONTROL SYSTEMS PROJECTS
INTRODUCTION

B-1. The complexity of Energy Monitoring and Control Systems (EMCS) requires a sufficiently detailed design package to enable contractors to have accurate bidding information to limit construction modifications, and to ensure a final product which will perform as intended by the designer. To accomplish a good EMCS design, a detailed field survey is essential.

B-2. This appendix describes the standard field survey procedures for EMCS design projects. The information outlined in this appendix explains the methods and data required for an EMCS survey in order to perform concept design and final design work.

B-3. A successful EMCS design requires a thorough and accurate field survey. During the field survey it is important to collect information including as built drawings, system types and operation, utility records and other items specifically related to the evaluation of an EMCS. The following sections explain these items, the extent of information required, and special considerations pertinent to obtaining that information. The material and backup documentation used to prepare the DD 1391 should be available for the designer in organizing and developing the survey.

a. Pre-Survey Requirements

(1) Pre-survey requires organizing the field survey personnel, organizing building data and equipment needed during the survey, and making arrangements with base personnel to conduct the field survey.

(2) The survey will involve working around dangerous equipment, and in high voltage areas. It is the responsibility of everyone involved in the survey to be familiar with proper safety precautions, and have the necessary safety equipment to conduct the field survey without injury or accidents.

b. Survey Personnel Requirement. The requirements and number of personnel on an EMCS survey vary depending upon the size and complexity of the facility. As a minimum the EMCS survey team will require the following personnel:

(1) *Mechanical Engineer*. An engineer with background knowledge in all types of mechanical air-conditioning systems, piping and distribution systems, and central plants. This person or persons should have experience with inspecting HVAC systems components (including controls if a separate controls engineer is not available for the survey).

(2) *Electrical Engineer*. An engineer with an electrical power background to analyze basewide and building power distribution systems.

(3) *Controls Engineer*. A controls engineer who is familiar with both local control systems and the hardware and software requirements of EMCS.

(4) *Technicians*. Technician level personnel may be used for much of the required data retrieval. The technicians should be experienced in mechanical systems and/or controls.

c. Organize Building Data and Test Equipment. Prior to the building survey it will be useful to prepare and organize all available information. The basic information which may be obtained before the survey includes building lists showing building functions (administration, living quarters, class rooms, etc.) and floor areas. The facility engineering personnel may have a list of the large mechanical systems and building locations which will be helpful in planning the site investigation. For the survey, the following test equipment is required:

(1) Digital temperature probe, or thermometer.

(2) Clamp on Volt-Amp-Ohm meter (watt meter preferred).

(3) Screw drivers and pliers.

(4) 50 foot tape measure.

(5) Survey forms and clipboard.

(6) Flashlights.

(7) Pressure gauges and air flow measurement instruments optional (only required if flow measurements are necessary).

(8) Boiler stack test equipment (if boiler testing is necessary).

d. Coordinate Survey with Facility Managers

(1) If the survey is being conducted with engineers not affiliated with the site, it is necessary to coordinate directly with the site facility managers (Civil Engineering Office (CE), Department of Engineering and Housing (DEH), etc.) regarding who, what, when, where and how the survey will be performed.

(2) The facility may need adequate lead time to perform security checks and issue passes on members of the survey team before they arrive. This is a good reason to inform the facility of who they are and when they will be coming. It will also help the survey process if the facility knows where and how the survey will be done. There may be classified areas on the facility which require special clearances or escorts. By telling the facility personnel what equipment will be included in the survey, site heating, refrigeration, or electrical shop personnel may be able to help in supporting the survey effort.

(3) Many times mechanical rooms or buildings at the facility will be locked. Advise the facility personnel how many sets of mechanical room keys will be needed so they can obtain extra keys before the survey team arrives.

B-4. Entrance Interview

a. An entrance interview should be conducted to present the purpose of the EMCS field survey. The personnel who should attend this meeting include:

(1) Government design representative.

(2) Architect-engineer design representative (where applicable).

(3) Facility engineer representative.

(4) Communication officer.

(5) EMCS personnel (if available).

(6) Other facility personnel as required (shop foreman, etc.)

b. During the meeting it is important to explain what will be done during the survey, and to get the input of the facility engineering commander, local engineering personnel, and local shop foremen who will be involved with the EMCS. These people should be able to give the survey team a good idea of the day to day problems, and special circumstances that are associated with a given facility. A key ingredient to a successful EMCS project is active participation by facility operating and maintenance personnel. The following items should be discussed during the interview:

(1) Who to contact for specific information on heating systems, HVAC systems, and electrical systems.

(2) Do any buildings have restricted access and how will the survey team obtain access or escorts.

(3) Who in the facility organization will be responsible for the operation of the EMCS once the system is installed.

(4) Possible locations for the master control room (MCR).

(5) How are existing as-built drawings organized, who is in charge of drawings, and what is the procedure for getting prints made.

(6) Who has utility data information.

B-5. As-Built Drawings

a. After proper coordination with site personnel, the first task in retrieving pertinent information is obtaining copies of as-built drawings. Depending on the age and amount of renovation of a particular building has experienced, the actual conditions may have changed to some degree from the way systems are shown on the record drawings. For this reason, all building and site drawings should be considered “suspect” until the pertinent information is verified in the field.

b. The drawings required for the survey include architectural, mechanical, and electrical. Structural and domestic water/sanitation piping drawings typically are not required.

c. Architectural Drawings. The architectural drawings required for the survey include the following:

(1) Building floor plans.

(2) Exterior building elevations.

(3) Exterior wall sections.

(4) Exterior roof sections.

(5) Related window/door details or schedules.

d. The drawings are required to obtain the necessary floor areas, and wall/roof heat transfer characteristics. During the survey the correctness of the architectural plans should be verified especially with respect to modifications to the exterior (i.e., added insulation, new windows, new roof insulation, etc.).

e. Mechanical Drawings. The mechanical drawings required for the survey include:

(1) Building floor plans with duct and piping layouts.

(2) Mechanical room details.

(3) Mechanical system schedules.

(4) Mechanical system details.

(5) Controls sequence of operation.

f. During the building survey, it will be necessary to verify all the mechanical systems for accuracy as shown on the record drawings, and to note any modifications and operational changes made to the units.

g. Electrical Drawings. The electrical drawings required for the survey include:

(1) Building lighting plans.

(2) Building power plans.

(3) Electrical one line riser details.

h. If lighting control is to be considered for the EMCS, the lighting drawings will have to be verified for accuracy during the building survey.

i. Site Plans. In addition to the building floor plans required for the survey, the facility site plans will be required to locate exterior systems. The site plans required for the survey include:

(1) General site plans with building locations.

(2) Electrical power site plans.

(3) Communication (telephone) site plans.

(4) Central heating piping (steam or hot water) site plans.

(5) Central cooling piping (chilled water) site plans.

(6) Natural gas piping site plans.

B-6. Utility Records

a. Historical records of site energy usage are required for the survey. As a minimum, the main site meter data must be obtained. If additional records exist for separate areas of the facility, building, or major systems, these items should also be obtained.

b. Fossil Fuel Historical Records. Fossil fuel consumption data will be required for all combustible fuels which are burned at the facility (i.e. fuel oils, natural gas, coal, etc.). Records for fuels such as fuel oils, propane, LPG, and coal will be based on when deliveries were made and may not track monthly usage. Billing data for natural gas will most likely be based on actual monthly usage and will be helpful in analyzing consumption. If facilities have central heating plants, there is a good chance local metering is available for this equipment. It is important to identify the heating values of all the fossil fuels used at the facility. The information obtained should also include both the amounts used (or delivered) and the total cost for each month. The amount paid is important because it reflects the difference in the fuel cost adjustments the utility may charge in addition to the fuel rate. At least one year’s worth of data should be obtained. When the fuel is purchased from a utility, the fuel rate and any fuel cost adjustments must be obtained in order to determine the total fuel costs.

c. Electricity Historical Records. Information on both electrical energy usage and electrical demand will be required for each month. Most facility electricity contracts are based on a special government service, commercial, or industrial rate which includes both an energy and demand charge. There may be special charges or penalties for poor power factors. It is important to obtain information on each chargeable quantity and the monthly costs in order to determine unit costs and the fuel cost adjustment charges of the utility.

d. Utility Rete Contracts. When obtaining fossil fuel and electrical utility records it is also essential to retrieve the rate contracts, and a name/ phone number of the utility representative for each specific utility. The rate contracts are necessary to correctly interpret the monthly billing data. For example, electric rates may include special time-of-day charges, step charges, or ratchet clauses for demand charges which are not readily discernible from the monthly bills.

e. Central Plant Data. At sites where buildings are served by central plants (such as steam, hot water, or chilled water plants) operator log data will be useful in calculating efficiencies.

f. Boilers. Monthly composite log data is normally sufficient for calculating boiler efficiencies. If special boiler selection is to be analyzed under the survey, representative hourly operator logs should be obtained for a winter, spring, and summer day. The information to retrieve from boiler operator logs includes:

(1) Steam flow.

(2) Steam pressure.

(3) Fuel input.

(4) Feedwater temperature.

(5) Makeup water quantity.

(6) Stack gas temperature.

(7) Stack gas concentration.

g. Use good engineering judgment when evaluating boiler records. Without good calibration, boiler steam records can sometimes be very inaccurate. If such is the case, or records do not exist, boiler efficiency testing will be required.

h. Chillers. Frequently logs are also maintained on large chiller plants. Hourly data on chiller loads and energy consumption can be useful in calculating chiller coefficients of performance (COP's) and evaluating the potential of such control functions as chilled water reset, chiller selection, and load shedding. Useful hourly logged data includes:

(1) Inlet and outlet chilled water temperature and pressure.

(2) Inlet and outlet condenser water temperature and pressure.

(3) Coincident outside air wet bulb and dry bulb temperatures.

(4) Chiller operating current (or steam flow for absorbers).

i. Combined with manufacturer's information (traceable through nameplate data), these values enable calculation of chiller performance characteristics.

B-7. Equipment Lists

a. Real Property Data. Facility real property records contain basic information for each building, such as function, square footage, and any major construction modification since it was built. These records also provide information on buildings or Systems which are scheduled for shutdown or demolition, and which therefore should be eliminated from further consideration.

b. Facility Engineering Data. In some cases, large mechanical system equipment lists are available from maintenance personnel at the site. These lists may contain detailed data on equipment manufacturers, model numbers, motor sizes, coils, controls, etc. This information must be field checked to ensure the equipment is still being used and no modification have been made. It is also important to talk with engineering and planning groups to determine what construction or remodeling projects are currently funded which may affect the EMCS project. These projects may include architectural changes that would lower EMCS savings, mechanical projects to replace existing equipment, or demolition projects on temporary type buildings. All of these projects need to be taken into consideration during the survey.

B-8. Building Survey

a. Most of the building survey investigative effort will involve surveying the equipment to be controlled. This includes verifying equipment, piping and electrical circuits, and tracing out local control loops. The purpose of the survey is to obtain enough information to locate all new and existing equipment on the drawings; develop EMCS control interface schematics for the plans; make details of equipment modifications for EMCS monitoring or control; and identify all repair and replacement items for the Systems Deficiency Survey Report.

b. Once the building selection has been finalized and all available records have been obtained on each building, the detailed building survey may be started. During the detailed building survey it is important:

(1) Verify all energy using equipment.

(2) Verify present and required operating conditions.

(3) Make preliminary selection of application programs.

(4) Note any equipment modifications required.

(5) Note existing building occupancy schedules.

c. Verify and Identify Energy Using Equipment. There are twenty-nine typical systems identified as mechanical/electrical units which can be controlled by an EMCS. During the survey, it is necessary to locate, identify and nameplate all systems which could be monitored or controlled by the EMCS. As-built drawings and equipment lists notes obtained must be identified for correctness before they can be used. The information which needs to be collected during the building survey differs depending on the type of systems found in each building. The data to be retrieved for different system types are listed below.

d. Air Handling Units. The broad category of air handling units (AHU) comprises many types of systems: single zone, multizone, reheat, variable air volume, fan coils, heating and ventilating, and unit heaters. All these systems provide heating and/or air-conditioning by forced air movement. The items of importance while surveying AHUs are:

(1) The type of AHU.

(2) The building area served by the AHU.

(3) Type of temperature control system.

(4) Types of coils (hot water, steam, electric, chilled water, etc.).

(5) Types of damper controls (fixed, modulating, economizers, etc.).

(6) Starter and motor type and size.

(7) Start up and operational items associated with the system.

(8) Summer/winter operational data.

(9) Equipment constraints.

(10) Valve.

e. Perimeter Radiation Systems. Perimeter radiation systems are heating units normally found in exterior zones of buildings, and are typically sized to match the beat losses from walls, window and doorways. The main items to be concerned about while surveying perimeter radiation systems include:

(1) The type of perimeter radiation system (steam, hot water, electric, etc.)

(2) The building area served by the perimeter radiation system.

(3) The type of temperature control system.

(4) Start up and operational items associated with the system.

(5) kW rating of the equipment.

f. Boiler and Converter. The main application program for large central plant boiler Systems is boiler selection. It is important to obtain data on the fuel types and usage of the boiler systems, their capacities, and combustion efficiencies.

(1) When central boiler systems provide heating to buildings via steam to hot water or hot water to steam converters, the converter capacities (including any storage and associated pump sizes) should be noted. On such systems, the EMCS will interface with the existing control loop to regulate the temperature or pressure output of the unit. It is necessary to inspect the control system to see what local control loops exist, and if additional control valves will be required.

(2) On most hot water systems, an important energy saver is outside air reset. The control systems should be inspected to see if local reset controls already exist. On hot water systems, pumps should be noted as candidates for EMCS controlled equipment.

g. Chillers and Compressors. When surveying chiller and compressor units it is important to identify which unit serves which air handling units. This is necessary to know whether an air-conditioning compressor system is serving AHUs which can be shut down during unoccupied hours, or AHUs which condition critical areas where the chiller needs to provide cooling 24 hours a day (i.e., computer areas, hospitals, etc.). The following information must be obtained:

(1) The type of chiller or compressor system.

(2) Rated capacity of the system.

(3) The compressor and auxiliaries motor data.

(4) The type of controls used on the systems.

(5) Method of condenser temperature control.

(6) Chiller alarms and interlocks (if any exist) for future monitoring by the EMCS.

h. Miscellaneous Equipment. There are a few systems which may be analyzed during the survey which were not included in the above system descriptions. These systems include, domestic water heaters, lighting systems, exhaust fans, water pumping systems, any miscellaneous loads which could be cycled or shut off on time schedules.

(1) Domestic water heaters may be either direct fired type using fossil fuels. Electric resistance type, or receive heat from a central plant. On this equipment it is necessary to note the tank capacity, setpoint, and heating input to the water heater.

(2) To accomplish lighting control through the EMCS, the power distribution systems lay out for the lighting circuits must be known. The number of branch circuits in a building should be identified and local switching arrangements (if any) noted. The lighting wattage for the building must be determined. Field verify the electrical plans to make sure the lighting layout has not changed. Note whether delamping (which will reduce the overall light wattage and possible EMCS savings) has been implemented.

(3) Field survey data required for exhaust fans include fan use (i.e. laboratory, toilet, etc.), horse-power, cfm, and present and required operating schedule.

(4) Other miscellaneous electrical or thermal equipment may not be identified as a standard system, but could offer the potential for energy savings through EMCS control. For such equipment note the capacity, and present and required schedule of operation. There may be savings by shutting the equipment off during hours when it is not required.

i. Verify Present and Required Operating Schedules. After inspecting the energy using equipment, the most critical data to retrieve is operating schedules of the equipment. Most of the savings estimated depend heavily on this information. Interview the building and operational and maintenance personnel to determine how the systems are currently operated. Are the fan systems left on during unoccupied hours, and the thermostats setback at night? It is also important to check if there are existing timeclock devices, and if they are working properly.

j. Next, interview the building manager to determine the actual required hours of operation for each system. If, for example an AHU is only providing conditioning to space for occupant comfort, then the system could be shut off during unoccupied hours. However, if the AHU is providing ventilation for special equipment (i.e., laboratory, computer, or special process area) or providing makeup air for exhaust systems, the AHU may need to operate 24 hours a day.

k. Verify Present and Required Environmental Conditions. While determining the operating schedules of AHUs and other equipment, it is also necessary to obtain the present and required environmental conditions for the building. Through interviews with building occupants, observations, and temperature (and humidity as required) measurements, determine what temperatures (and humidity) are maintained during a normal day.

(1) There may be facility guidelines which establish environmental requirements for various types of spaces. If so, these requirements should be noted.

(2) Generally, if a building is conditioned for only occupant comfort, the systems should be shut off during unoccupied periods and the temperatures allowed to float in the building. If there is special process equipment or materials located in the building, the building personnel should identify these areas as zones where the EMCS must maintain constant temperature and/or humidity setpoints.

l. Identification of Equipment Modifications. If the implementation of the EMCS requires some modification to a piece of mechanical or electrical equipment, sufficiently detailed information must be obtained during the survey to estimate the cost for the modification and to show the modification details on the drawings. Areas where mechanical and/or electrical modifications may be necessary include things such as:

(1) Ductwork additions or change.

(2) Piping additions or changes.

(3) Additional fans or pumps.

(4) Control circuit components.

(5) Disconnect switches.

(6) Electrical service changes.

m. Some examples are:

(1) If duct modifications will be required to provide 100 percent outside air capability for economizer controls, it will be necessary for the engineer to determine if adequate room is available and how extensive a change is necessary to install new ducting, dampers and actuators.

(2) AHUs, to which the economizer program is applicable must have 100 percent outside air (OA) intake and relief capabilities. If this has been recommended on a system, and the AHU does not have 100 percent OA flow ability, the engineer will have to survey the fan system to determine how to add the necessary ducting, dampers, and outside air intake and relief louvers:

(a) Locate position and dimensions for new outside air, return air and relief air dampers.

(b) Determine if pneumatic control air is available, and if so where the closest connection is to the main air source.

(c) Determine new duct routing for 100 percent OA intake and 100 percent return and exhaust air (EA).

(d) Locate position, wall construction, and dimensions of new OA and EA louvers.

(3) On systems where new control valves are required for EMCS applications programs, the engineer will have to field check the as-built drawings to verify such things as:

(a) Piping location accuracy.

(b) Pipe dimension.

(c) Any modifications which would change the required maximum flow rates in order to properly size the valves.

(d) If pneumatic control systems are used in the building and where the closest main air connection is to the new valve.

(e) Where to locate additional pipe hangers for large valve bracing.

(4) In addition to checking piping location for the new valve, it is important to retrieve the nameplate data from pumping systems to later verily that changes in the piping system pressure will not harmfully affect the flow or pumps. On steam systems, it is also necessary to:

(a) Identify the steam pressure where the valve will be installed.

(b) Locate where new condensate piping can be connected into the existing system, with pipe dimensions verified.

(c) Decide how bypass connections around steam valves can be installed.

(d) Locate any new traps required for new valves.

(5) Where totally new pump or fan systems are going to be added, the exent of field notes required is left to the design engineer to be as complete as required to show all demolition and new design work in the design drawings.

(6) Any new modifications should be laid out after carefully field verifying the as-built drawings. Photographs will be helpful for future reference, and may also be good for adding to the drawings to clarify modification requirements.

n. Identify Input/Output (I/O) Point Selection. During the survey it is also necessary to identify the application programs which are applicable to the particular systems identified in each building. The I/O summary tables provide listings of EMCS hardware and software as applied to typical systems. By starting with these prescribed EMCS functions, add or delete those functions that may or may not be applicable for each system surveyed.

o. System Deficiency Survey Report. The existing control devices that must be repaired or replaced in order for the system to be in good working order, as determined by a visual inspection and operational check, must be noted during the survey. This information is necessary for inclusion in the Systems Deficiency Survey Report which also must include the estimated cost to repair and/or replace.

p. Although existing local control loops will need to be modified to include the interface required for EMCS control, *the existing local loop control system must remain and perform as originally designed, except for existing time clocks, which are to be removed.* Therefore, during the survey, data must be collected in order to show the existing control loop, and exactly how the EMCS will interface, modify, or replace parts of that control loop. It is also necessary to show the proper predetermined failure modes of the equipment. Because of these design requirements, during the field survery it is necessary to verify how each control loop is presently connected and operated, and identify the required failure mode for each control loop and piece of equipment. The following sections describe what is involved in this procedure for both electric/electronic and pneumatic controls. This portion of the field survey will require the most time intensive efforts for the engineers and technicians. Note the testing of the control loops will involve contact with dangerous conditions such as working around high voltage locations. Survey personnel should be experienced and trained in proper safety habits, and have access to proper safety gear to prevent accidents and injury.

q. Electric/Electronic Controls. One of the most common electric control loops with which the EMCS will interface is the starter circuit on fans, pumps, and refrigeration equipment. There are a number of possible starter types which may be encountered on a field survey, and a large number of interlock devices tied into the starter circuits. It is the responsibility of the surveyor to trace out the complete starter circuit to determine how the starter circuit is presently wired.

(1) A typical starter wiring circuit for any AHU is a magnetic starter and handoff-auto (HOA) switch. There may also be a timeclock and setback low limit thermostat connected into the auto leg of the HOA switch. There may or may not be existing timeclocks in the existing starter circuits. If there are timeclock devices in the existing control loops, they must be identified on the survey, because they are to be removed for the EMCS design. In addition, two starter interlocks are generally in the circuit, a firestat and a freeze-stat. On AHUs, it is normal to find one or both of these override devices on a starter circuit. It is important during the survey to trace through the starter circuit to identify if these interlocks exist, if they are still tied into the starter circuits, and if the interlock is still functional.

(2) The interlock can be tested easily by adjusting the setpoint to see if the contacts open and shut off the starter. Local controls with which the EMCS will interface, but are broken, need to be identified so they can be replaced. In addition to identifying each component and interlock in a starter circuit, the holding coil voltage must be identified. In some cases this may be a low voltage circuit (12 or 24 volts), but in other cases it is line to line, or line to neutral (208, or 120 volts).

(3) Another possible starter configuration is a momentary push button starter. Once the starter button is pushed, the auxiliary contact on the starter will maintain power to starter coil until either the stop button, or other interlocks break the power. It is important during the field survey to:

(a) Trace the entire circuit to identify all components which affect the starter.

(b) Test the interlock devices to make sure they function properly.

(c) Determine the holding coil voltage.

(4) In some instances, there will be control diagrams available to help in identifying how the control circuits are wired. However, these control diagrams need to be field verified to make sure they have not been modified.

(5) One of the best ways for the EMCS to interface with a direct expansion (DX) condensing unit is to wire an EMCS output control relay in series with the liquid line solenoid valve (LLSV) control. This valve is usually activated by a space thermostat, or discharge air temperature control, depending on the type of AHU. Here is it important to:

(a) Identify the controls tied into the LLSV control circuit.

(b) Verify how the fan system is interlocked

(c) Identify the control voltage used for the LLSV.

(6) For small DX systems the fan interlocks may be accomplished directly in the through internal switching.

(7) The three previously described examples addressed circuits which are intended for EMCS *control.* It is also important to understand and survey existing circuits intended for EMCS *monitoring.* A good example of this is monitoring the starter relays on a refrigeration compressor for the EMCS "status" function. By installing a status relay in parallel with the compressor starter coil, the EMCS will be able to monitor run time and alarm status on the compressor. On this type of local control loop, it is not as critical to trace every component in the chiller control package because the EMCS will not interface for override control. The EMCS is merely intended to monitor the status. It is, however, important to determine the control voltage of the starter relay for the design.

(8) EMCS interface to electric and electronic controllers for dampers and valves is a much more complicated procedure because the controllers and control devices are not standardized across the controls industry. Therefore, it is important to not only trace out control loops with which the EMCS will be interfacing, but also to note all the control hardware manufacturers and model numbers. On electric and electronic controllers which use varying resistance input signals, control set point adjustment (CPA) requires that an extra set of terminals be provided. For this type of controller:

(a) Note the control loop configuration.

(b) Note the controller manufacturer and model number.

(c) Note if the controller has an extra set of terminals available for a remote CPA input.

(d) Test the controller to see if it is working by forcing the device to make a control change.

(e) Test the controlled device (damper or valve) to see if the unit is working.

(f) Note any other control hardware which needs repair, such as damper linkages, etc.

(10) Pneumatic Controls. The EMCS interfaces to pneumatic control systems are basically of two types: (1) two position override and (2) control point adjustment (CPA) of reset controllers. The surveyor should be aware what type of control application the EMCS will be performing in order to properly survey the pneumatic control system. For the survey, it is necessary to:

(a) Trace out the pneumatic control loop with which the EMCS will interface and determine the function of each device.

(b) Establish if a new controller is required.

(c) Determine the control action of the pneumatic control loop, either direct acting or reverse acting.

(e) Test the controller and the controlled device to see if both are functioning.

(f) Note any problems or repairs required, such as dampers, damper linkages, etc.

(g) Find the closest connection to main pneumatic air and verify quality of air.

(11) Existing pneumatic local control systems which use a sensor, receiver/controller, and pneumatic operator, require a separate CPA port on the controller in order for the EMCS to change the setpoint. Therefore when surveying control loops which require reset, determine if the existing controller has a separate CPA port. If the existing controller does not have a CPA port, a new reset controller must be provided. For the survey, it is necessary to:

(a) Trace out the pneumatic control loop with which the EMCS will interface.

(b) Establish if a new controller is required.

(c) Determine the control action of the pneumatic control loop, either direct acting or reverse acting.

(d) Test the controller and the control device to see if both are functioning.

(e) Note any problems or repairs required, such as dampers, damper linkages, etc.

(f) Find the closest connection to main pneumatic air.

(12) A pneumatic economizer controller functions in a similar manner to its electric/electronic counterpart. Various temperature inputs are made to a single economizer logic controller, which then sequences the dampers and valves. During the survey, note the logic controller manufacturer and model number, and the type of inputs used on the controller. Also note if there is a separate CPA port available for remote setpoint adjustment for the EMCS.

r. Electrical Power. At each building, new electrical power will be required for FIDs, MUXs, and other control devices, such as transformers, control actuators, etc. During the survey, it is necessary to identify where the contractor will obtain power for EMCS devices. Basically, the easiest power source will be from existing electrical panels (EEP). It is best to identify an EEP located near where it will be used (i.e., by the FID/MUX panel). FIDs and MUXs must be powered by individual circuits from the EEP. Generally, the power source should be 120/208 volt, 3 phase, 4 wire system. If this power type is not available, it needs to be noted on the contract documents so that the contractor can provide the necessary transformer to power his equipment.

(1) During the survey, identify the following information about building electrical power sources:

(a) Indicate EEPs.

(b) Note the panel voltage (i.e., 120/208V, 3 ph, 4 W, etc.).

(c) Note if the panel is recessed.

(d) Note if there are at least two spare breakers available with no loads attached.

(e) If there are no spare breakers available, note if there are knock out spaces available on the EEP.

(f) If there are no spares or spaces available, note that a new sub-panel will need to be provided for the EMCS and note a suitable location for mounting the new panel close to the EEP.

(2) FID/MUX/PLC/DTC Mounting Location and Interface. During the survey, locations must be noted for the FIDs, MUXs, PLCs, and DTCs. Based on this data, a suitable location in the building must be identified on the drawings for mounting the panels.

(3) Sensor and Control Mounting Location. While surveying buildings for local control interface, it is also necessary to locate where new sensors and controls for the EMCS should be mounted. It is this equipment which the contractor must mount in suitable locations from details on the drawings.

(4) Temperature Sensors. There are a number of standard types of temperature sensors used to monitor temperature conditions in the data environment. Space temperature sensors are the most common. During the survey, it is necessary to identify the location of each sensor. The following items should be kept in mind:

(a) The space temperature sensor (STS) must give an accurate indication of the average conditions (hot or cold) for a particular system. More than one STS may be required.

(b) Think about possible solar effects on the space temperature. Don't locate the sensor directly in the sun.

(c) Do not locate a space temperature sensor on an exterior wall. Inaccurate readings may result due to the temperature of the exterior wall.

(d) The time and cost for the installation of the temperature sensor will be reduced by locating it near a wiring or mechanical chase.

(e) The standard mounting height of a space temperature sensor is 54 inches above the finished floor. The mounting location should not have any existing obstructions at this level.

(f) Avoid locating sensors near heat generating equipment such as coffee pots, word processors, copy machines, etc.

(g) Locate STS in areas which are served by the mechanical systems they are associated with. A single sensor may be associated with more than one system (for example hot water perimeter radiation and a DX-AHU serving the same area).

(6) Duct temperature sensors are used to indicate supply, return, and mixed air temperatures in AHUs. During the survey, determine the location in the duct where the most accurate indication will be for duct temperatures. If sensors are located too close to 90 degree turns, or fan discharges, the duct temperature sensor may not get accurate readings. Averaging type sensors should be used in ducts where air of differing temperatures are mixed. Where ever possible during the survey, find long straight sections of ducting to locate the temperature sensors.

(7) Water temperature sensors are used to measure the supply and return temperatures of conditioned water. It is important during the field survey to identify where water temperature sensors are to be located on the drawings. Verify the pipe location and dimensions. On small diameter pipes, the designer may wish to install an enlarger/reducer section in order to have a minimum pipe size for installing an immersion well for the sensor. If this is the case, locate a suitable location in the piping where existing valves isolate the pipe section, and insert an enlarged pipe section.

(8) When locating suitable mounting for the outside air temperature sensor and weather shield, the location should minimize effects from wind, rain, solar, and radiation from nearby structures. During the survey, make note of the exterior wall construction which will need to be included in the design drawings to identify the type of wall penetration required.

(9) For special temperature applications, the surveyor must gather enough information on the field survey to complete the design adequately.

s. Humidity Sensors. Surveying buildings for the mounting of humidity sensors requires the same consideration as discussed in paragraph B-8r(4) temperature sensors. If the sensors are used for space humidity monitoring, they need to provide an accurate indication of the average conditions. For duct humidity monitoring, make sure the sensor is located in the duct so that it gives an accurate reading of the air stream. See paragraph B-8r(4) additional mounting considerations.

t. Pressure and Temperature Switches. Monitoring status of fans and pumps requires positive indication that the system is moving air or water. A differential pressure switch (DPS) usually is the best method. During the survey, locate where and how to mount the DPS. On fan systems, the DPS is normally mounted directly on the ducting next to the fan, with copper tubing punched through the suction side and discharge side of the fan. Make field notes as to where there will be easy access to mount the DPS on the fan.

(1) On pumping systems, installing the DPS copper tubing across the pump can be more complicated. During the survey, note if pumps have taps on the pump casing, or have existing gages tapped into the suction and discharge side of the pump. These can be used to install the DPS. If they are not available, they will have to be added as part of the EMCS design.

(2) When temperature switches are being used in lieu of sensors, the surveyor should keep in mind the same factors described for locating proper mounting of the switch. See paragraph B-8r(4) additional considerations on mounting temperature switches.

u. Control Relays. During the survey, evaluate whether it would be more economical to locate EMCS control relays in individual enclosures near the motor starters or a motor control center, or in a relay cabinet adjacent to the FID/MUX. If the designer opts for a relay cabinet, it will be necessary to field verify a mounting location for the extra panel. The desired mounting heights and location should take into consideration ease of future maintenance. The dimensions of a relay cabinet will vary depending on the number of relays used.

v. Pneumatic Controls. EMCS interface to existing pneumatic controls requires the mounting of new pneumatic hardware (i.e., pneumatic controller, 3 way pneumatic solenoid valves, etc.). During the survey, it is necessary to identify where new pneumatic devices will be mounted. If there are existing control panels, the surveyor should investigate whether there is sufficient room to mount the necessary additional hardware. If there are no panels or available room, it is necessary to locate a new local control panel to mount the new EMCS pneumatic interface hardware. The desired mounting height and location should take into consideration ease of future maintenance.

w. Building Wiring. During the survey, it will be necessary to note all interior and exterior wall and ceiling construction throughout the building where wiring will be run. If wiring cannot be run concealed, note how and where new conduit shall be installed (for example, run conduit exposed across ceiling of ship area). Also note all ceiling heights where wiring will be run. Providing accurate information on ceiling and wall types in the design documentation will reduce the conduit installation and materials cost of the EMCS.

B-9. Master Control Room

The amount of data which must be obtained during the field survey for design of the Master Control Room (MCR) depends a great deal on how much remodeling is needed in the area. For large and medium EMCS projects, all new mechanical and electrical services may be required, in addition to architectural modifications. For small and micro EMCS projects, the changes for the MCR may be minor. The following sections will give some general guidelines to follow. It is the responsibility of the designer to determine what level of detail is required for the specific job.

b. Architectural Requirements. The final architectural design of the MCR includes two main areas: demolition, and installation of new architectural components, such as walls, floors, and/or ceilings. During the survey, it is necessary to note all existing conditions that will affect either the demolition or installation design. There items include:

(1) All room dimensions, including doors, windows, and other major fixtures in the area.

(2) Wall constructions, including heights, foundations, thermal and moisture barriers.

(3) Floor construction, including floor coverings and baseboards.

(4) Any fixtures or special accessories which are mounted on the walls or floors.

(5) Ceiling construction, including insulation, thermal and moisture barriers.

(6) Reflected ceiling plan, with light and diffuser locations.

(7) Structural construction for possible support of equipment.

c. Only by “as-builting” the architectural components of the proposed MCR will the designer be able to clearly show the necessary demolition and new construction.

d. Mechanical Requirements. Data for accurately calculating the MCR cooling and heating loads must be obtained along with data on any existing cooling and heating equipment available. This includes:

(1) The lighting and equipment heat load.

(2) The wall, ceiling, window, and door construction to calculate heat loss/gain (same as data required in architectural section).

(3) The heating and cooling capacity available to the MCR from existing HVAC equipment (coil capacities, air flow rates, etc.).

(4) Possible mounting location of new HVAC equipment, such as the fan unit and condenser.

(5) Utility services for new HVAC equipment, such as electrical, gas, domestic water, or condensate drain to sewage connections.

e. There may be additional information requirements. It is up to the engineer to determine what the applicable MCR design criteria calls for before surveying the mechanical systems. Make special note of any mechanical systems which should be included in the demolition, for example a window fan coil unit that is not going to be used for the MCR.

f. Electrical Requirements. The electrical power source must be of sufficient capacity to handle all the EMCS equipment, plus any air-conditioning and lighting requirements.

(1) During the survey, it is necessary to determine if there is sufficient spare electrical capacity on existing equipment to handle the new electrical loads for the EMCS. If the existing electrical capacity is insufficient, new electrical distribution equipment will be required.

(2) Provisions for electrical service to power conditioning equipment must be considered. The surveyor should identify the mounting location for the equipment and the line side voltage available to the contractor.

(3) Lighting for the MCR is an important item and special notes should be taken to identify existing lighting fixtures, switching, and any emergency lighting available. Note all existing receptacles available in the MCR for future use on the design drawings.

B-10. Energy Metering

a. Energy meters should be located at the public utility service point and additional energy meters may be installed at the building level. The field survey requirements for these two areas are scribed below.

b. Main Site Utility Distribution Metering. The electrical meters at the point of service by the utility company must also be metered by the EMCS if electrical demand control is implemented. During the survey, determine the location of all the electric meters used by the power company for billing the facility. The EMCS will need to monitor all of the same points. In most cases this will involve only one main point where the utility company substation or transformer banks are located. The utility company generally will provide a meter output from their meter at the request of the customer. This can be verified through the utility company representative. Have the utility representative give the designer a quote for the cost, along with a special name, address, and phone number for future reference.

(1) During the survey, it is important to determine how to wire to the output contacts of the meter. Many times on a large facility to the utility substation is enclosed, and at a site which is remote to most of the facility. It is up to the engineer to determine the best location for mounting a MUX or FID, and how to wire the DTM and meter contacts.

(2) If gas or other main utility metering is being considered, the same approach is recommended for existing meter locations. In many cases a pulse contact may be added to the existing meter head for the EMCS to monitor.

c. Building Submetering. For building submetering, there are a number of different energy and flow measurements which may be taken. For gas or liquids, determine the fluid to be measured (gas, water, steam, etc.), and its maximum flow rate. For electrical service metering, determine the secondary voltage to the building and the maximum amp service. With this data, cost estimates can be developed for installing building and equipment submetering.

B-11. Data Transmission Media

a. Since the DTM will be specified in the basic EMCS contract to be contractor furnished and contractor installed, it is very important for the engineer to study the various DTM alternatives.

b. There are three methods available for DTM. They are fiber optics, wirelines, and radio frequency (RF). Each DTM type has its economic and technical benefits. The preferred DTM is fiber optics or wirelines. The selection will be based on economics and the particular site requirements.

c. Coordination With Communications Officer. Any new communications systems at a facility will have to be coordinated with the local communications officer for approval.

(1) For DTM to be installed on existing aerial poles, it is necessary to meet with the communications personnel on the base and go over the proposed DTM routing on site plans showing existing telephone and electrical power poles. The local communication office should be able to identify all rights-of-way for locating DTM on these poles. In addition, if the facility has specific design criteria for installation of overhead wires, the communications office should provide these guidelines.

(2) For DTM to be run underground direct buried, the communications office should be able to explain on site plans where there may be special obstructions, or rights-of-way problems. On some facilities where communications wiring is run underground there may be spare conduits available for special applications, such as EMCS or fire/security. Communications office approval is required to use these conduits.

(3) Coordination for the use of radio frequency equipment involves getting approved frequencies to transmit data signals to receivers on the facility. The communications office may help in identifying any problem areas to reach with RF signals (for example, behind obstructions or if there is other RF noise interference).

d. Fiber Optics and Wireline DTM Application. During the survey identify how the DTM will be installed. Each facility will have its own design criteria for installation of communication cables.

(1) In some instances the DTM will have to be run overhead, on poles, and in some cases it will have to be run underground.

(2) After identifying the routing of the DTM from building to building, it will also be necessary to locate the DTM entrance to the building floor plan where the contractor is to mount the cable terminations and junction boxes. Also note the exterior wall construction, which is needed for wall penetration details and cost estimating.

(3) Once the basic method of installation of the cabling has been determined through coordination with the communications officer, a visual survey with the facility site plans should be conducted to verify pole locations, direct buried cable obstructions, etc., which will affect the construction cost estimate of the DTM.

e. Radio Frequency DTM. The use of radio frequency (RF) DTM involves the installation of radio receivers and transmitters for data communications. Coordinate the possible use of RF with the communications officer to avoid problems with the availability of radio frequencies for data transmission. On some facilities, all available frequencies are used and RF will not be feasible.

(1) In surveying a facility for RF DTM, it is necessary to look at the local geography. Make note of large hills and valleys which may obstruct the communications of the RF. Also, determine where the main transmitter antenna should be located. Many times a tall building will provide a suitable location for elevating the antenna system. If there is no available tall building, an alternative location for a new antenna tower will have to be identified. The transmitter for the RF has to be located in close proximity to the antenna. If the antenna is located on top of a building, the transmitter could be located in the building. If a new antenna tower is built, it is possible a new enclosure may have to be constructed to house the transmitter.

(2) Since the RF DTM is only used for communication between the EMCS central equipment and the FIDs, the designer must choose an alternate DTM for FID to MUX communication.

(3) During the field survey, it is the responsibility of the designer to determine the RF configuration. Based on the cover pattern of the par facility, the designer needs to locate base station, remote base station (optional), repeaters (optional), FM transceivers, and antennas.

(4) The base station (and remote base station), repeaters, and remote transceivers should be located on an accurate topographical map. Radial lines drawn from the base station or repeater to each remote station will then indicate potential obstacles along the lines of site.

(5) The mounting location for all antenna systems must also be identified. Special attention should be given to grounding and lightning protection requirements for the antenna, and any other specific problems such as special towers, roof mounting and reroofing, or guy wires.

(6) The receiver signal level for each location should also be established as part the RF system design, as well as the location of all components. Finally, adequate power sources for the equipment must be identified.

B-12. Survey Data For DD Form 1391 Validation

a. The information used to generate the DD Form 1391 will be given to the designer for validation. During the field survey, it will be necessary to collect data for this validation. The two major areas are energy savings and cost analysis.

b. System measurements of large equipment for energy savings may be required since simple estimates may not be sufficiently accurate. During the building survey, data collection is required to verify the building energy characteristics.

B-13. Exit Interview

a. If the survey is being conducted by personnel from off the facility, it is appropriate to schedule an exit interview when the survey is completed. During the exit interview it is helpful to:

(1) Discuss problems identified during the survey which will affect the EMCS.

(2) Identify additional information which the facility needs to provide for the design.

(3) Identify any special areas which the facility would like addressed.

(4) Answer further questions regarding the design of the EMCS.

b. Maintaining good communications and personnel relations during the survey and design is critical in order to maintain facility support for an EMCS.

B-14. Documentation of Results

a. After completing the survey, compiling and organizing the data will help in determining whether the data is complete. All field survey notes and sketches should be dated and initialed by the engineer in charge of the survey. In many cases, changes will occur during and after the EMCS design. If there is any question as to the conditions at the time the notes were made, it is important to have the date and person responsible for the survey data. During this period, it is also important to write a short memorandum to summarize the results of the field survey. This memo should include:

(1) A list of those people who were involved in the survey.

(2) The time and dates of the survey.

(3) The list of names and phone numbers of people contacted at the facility.

(4) Any special problems or comments related to the EMCS design.

(5) General progress made on the survey.

(6) Notes from the entrance and exit interviews with facility personnel.

b. This information will help in later years if questions arise regarding design decisions developed based on meetings at the facility, and the reasons why these choices were made will be documented.